

Study on *Platanus hispanica* Miller pollen content in the air of Seville, southern Spain

Francisco José González Minero *, Pilar Candau

Dpto. Biología Vegetal y Ecología. Facultad de Farmacia, Apdo. Correos 874, E-41012 Sevilla, Spain

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Abstract

The work was carried out using a Cour trap that sampled the air of the city for 8 consecutive years (1987–1994). The pollen of *Platanus hispanica* is the fourth most abundant in the air of Seville (a mean of 11.05% of the total pollen collected). The variation throughout the years in the sum of weekly concentrations of *Platanus hispanica* pollen presents a certain biennial rhythm, in which years of high and low collection of pollen alternate. The starting day of the main pollination period (MPP) is negatively related with the mean of the mean temperatures for February ($r = 0.73$, $r^2 = 0.53$, $P = 0.0398$) and is earlier (at the beginning of March) when the mean temperature for February is high, and vice versa. The pattern of pollen variation in *Platanus hispanica* remains constant through the years—pollen appears abruptly in high weekly concentrations (> 150 grains/m³) in March (sporadically at the beginning of April), with a week of maximum pollen emission (WMPE) in which more than 50% of the annual pollen is collected (in 6 of the 8 years), and a main pollination period (MPP) of 2 or 3 weeks (except in 1989 when it was 5 weeks). In every year (except 1989), weekly mean temperatures increased during the MPP, the duration of which depends on mean temperature and mean rainfall: mean temperatures $> 16^\circ\text{C}$ and absence of rainfall shorten the MPP, while lower temperatures and presence of rainfall lengthen it. The meteorological conditions most often found during the WMPE are mean temperatures $> 15^\circ\text{C}$ and rainfall absent or almost so. © 1997 Elsevier Science B.V.

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1. Introduction

The aeropalynological literature includes many works dealing with total pollen content in the air of many cities and regions of the world (especially in developed countries). There are also numerous individual studies on pollen types having recognised incidence in allergic processes: *Gramineae* (Spieksma et al., 1985; Subiza et al., 1991), *Olea europaea* (Candau et al., 1981; Gioulekas et al., 1991; Macchia et al., 1991; Domínguez-Vilches et al., 1993), *Urticaceae* (Emberlin and Norris-Hill, 1991; Corden and Millington, 1991; Fornaciari et al., 1992; Negrini et al., 1992), *Fraxinus* (Candau et al., 1994), *Betula* (Wallin et al., 1991), etc.

However, the literature is poorer in monographic research of taxa with high atmospheric representation and possible repercussion in allergies, as could be the case of *Platanus hispanica*. A work carried out in the city of Madrid shows the incidence of *Platanus* in pollen allergies (Subiza et al., 1994).

Platanus hispanica is common in the ornamental flora of numerous cities and its pollen is very abundant in the pollen spectra. These two characteristics are enough for this pollen type to be a potential etiologic agent of more or less severe allergenic processes, though up to now only moderate or low allergic power is known for it (Surinyach et al., 1956; Stanley and Linskens, 1974; Lewis et al., 1983; Solomon, 1984; Bousquet et al., 1984; Chapman, 1986; Eriksson et al., 1987; D'Amato and Spieksma, 1991; Negrini, 1992).

* Corresponding author.

Table 1

Sum of the weekly pollen concentrations of *Platanus hispanica* pollen, percentages of annual representation of *Platanus hispanica* pollen in the total pollen collected by the end of each year, and amount of annual rainfall and that preceding the pollen season

Year	Total pollen (Grains/m ³)	%	Rainfall annual (mm)	Rainfall pre-seasonal (mm) ^a
1987	1599.45	13.30	811.4	400.3 (86–87)
1988	1163.04	9.25	506.1	518.8 (87–88)
1989	1757.39	14.65	940.6	384.4 (88–89)
1990	820.46	9.15	414.2	826.2 (89–90)
1991	1042.92	13.09	566.5	292.6 (90–91)
1992	2119.76	9.30	369.8	362.7 (91–92)
1993	811.22	9.76	315.3	128.6 (92–93)
1994	1122.47	10.35	315.1	161 (93–94)
Average	1304.59	11.05		

^a Period: 1 September of the previous year–last day of February of the stated year.

The work is based on 8 consecutive years of meteorological and aeropalynological observations, the latter carried out with a Cour trap installed in the city of Seville. The bibliographic contribution is from our Aeropalynology group, whose first results of *Platanus hispanica* phenology, based on an airborne pollen count, are given (Cepeda and Candau, 1990).

2. Materials and methods

The city of Seville is located in the Guadalquivir valley (37° 27'N, 5° 58'W). It is the most heavily populated of the Andalusian region (> 1 000 000 inhabitants, including suburban residents). Its climate is dry Mediterranean—frosts are rare, and rainfall is distributed irregularly, both through the year (absent during the summer) and from year to year. The mean annual temperature is 18.8°C, annual rainfall is 600 mm, and annual sunshine reaches 2444 hours (data provided by the National Institute of Meteorology, Tablada Observatory, Seville: period 1922–1989). The inner city has 1374.644 m² of green areas distributed in four large parks and 18 small parks (not including the trees on avenues and in numerous private gardens). Seville has a notable presence of *Platanus*—estimated as more than 10 000 trees—which is not only decorative but also provides the effect of an enormous, very efficient parasol for pedestrians.

The pollen count of airborne pollen of *Platanus hispanica* was carried out using a Cour trap (Cour, 1974) installed at a height of 15 m on the flat roof of the School of Pharmacy, Seville University. The collector monitored the air of the city uninterruptedly for 8 consecutive years (1987–1994). Together with the trap was a totallising anemometer to measure the airflow through the filter during the exposure period. The pollen concentrations are calculated as a function of the pollen grains retained on the filter and the total airflow through it. As the exposure period of the filters is

weekly, the Cour method allows a knowledge only of weekly pollen concentrations, and it is not possible to establish either hourly or daily concentrations.

The meteorological data appearing in this work were obtained from meteorological information sheets provided by the National Institute of Meteorology (Regional Weather Centre of Seville).

The concepts 'main pollination period' (MPP) and 'week of maximum pollen emission' (WMPE) have been used in this work. The MPP for a determined pollen type is those weeks of the year in which is collected between 5 and 95% of the total pollen captured by the end of the year (Pathirane, 1975). The WMPE is that week of the year when the maximum concentration for a determined type is recorded.

3. Results

Table 1 shows the sum of the weekly pollen concentrations of *Platanus hispanica* for each year. The mean value is 1304.95 grains/m³ (mean of 8 years), with a difference of 1308.54 grains/m³ between the years of maximum (1992) and minimum (1991) collection. The variation over the years in the sum of weekly pollen concentrations of *Platanus hispanica* pollen follows a biennial rhythm, in which the years of high and low collection of pollen alternate, (although this rhythm was broken in 1992 (Table 1, Fig. 1). This variation in the sum of weekly pollen concentrations of *Platanus hispanica* pollen took place during a period which included years of great differences in rainfall: in the first 3, rainfall was abundant, while in the last 5, annual rainfall did not exceed a mean of 600 mm. The 3-year period 1992–1994 was especially dry, and rainfall did not exceed 400 mm annually (Table 1, Fig. 1). Table 1 also shows the rainfall prior to the pollen season of *Platanus hispanica* (1 September of the preceding year to the last day of February). It can be seen that during the first 5 years of the study (1987–1991), the courses

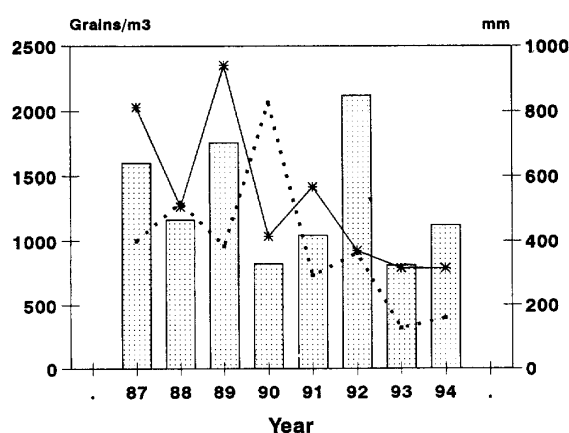


Fig. 1. Variation of the sums of weekly pollen concentrations of *Platanus hispanica* (grains/m³), annual rainfall (mm), and rainfall of the months previous (1 September–last day February) to pollen presence in the air.

of the annual pollen curve of *Platanus hispanica* and the curve of pre-season rainfall are inverse, while from 1992 the two curves are parallel (Fig. 1).

The mean percentage of *Platanus hispanica* pollen in the total pollen collected was 11.05% (1987–1994), with the lowest in 1990 (9.15%) and the highest in 1989 (14.65%) (Table 1).

The mean starting day of the MPP was 13 March (day 72 from 1 January). This date could be earlier by 9 days (4 March—day 63; 1989) or delayed 19 days (1 April—day 91; 1991) (Table 2). This maximum difference of 28 days in the starting day of the MPP through the years was related with the means of the mean, maximum and minimum temperatures for February (Table 2) (the month prior to the appearance of *Platanus hispanica* pollen in the air). A negative correlation was found between the mean temperature for February and the starting day of the MPP ($r = 0.73$, $r^2 = 0.53$, $P = 0.0398$). The equation relating these two parameters is $D = 140.13 - 5.631 T_{\text{mean}}$, where D is the starting

day of the MPP and T_{mean} is the mean of the mean temperatures for February. The coefficients of correlation between the starting day of the MPP and the mean of the minimum ($r = 0.70$, $r^2 = 0.49$, $P = 0.0517$) and maximum ($r = 0.66$, $r^2 = 0.44$, $P = 0.0742$) temperatures for February are not significant.

The pattern of variation in the weekly concentrations of *Platanus hispanica* pollen remained constant over the years, and is characterised by weekly concentrations higher than 150 grains/m³ during a few weeks between March and April (Fig. 2): 1 week (1994), 2 weeks (1988, 1990, 1991 and 1992), 3 weeks (1987 and 1993) and 5 weeks (1989). Moderate amounts of *Platanus hispanica* pollen could also be found in July and the months of autumn. The week of maximum pollen emission (WMPE) varied from year to year, with the maximum value in 1993 (1216.36 grains/m³) and the minimum in 1992 (427 grains/m³)—a high percentage of *Platanus hispanica* pollen, and more than 50% of the annual pollen of this taxon; but it did not occur in 1988 and 1989 (Table 3). In the annual pollen pattern, there was usually another large peak of concentration later than the WMPE when the weekly concentration was approximately 1.5 times lower than that of the WMPE, as can be seen for 1988, 1991 and 1992 (Fig. 2); in the other years, there was no second peak of concentration, and the concentrations were very much lower than that of the WMPE (generally two or three times lower) (Fig. 2).

The meteorological conditions recorded during the WMPE included temperatures higher than 15°C (except in 1987), an increase in the mean temperature compared with that of the preceding week ($> 1.5^\circ\text{C}$ in 1988, 1989, 1992, 1993 and 1994; > 0.5 – 1.5°C in 1987, 1990 and 1991) and rainfall absent or almost so (except in 1987) (Table 3).

During the periods of main pollination (MPP) there was an increase in weekly mean temperatures between the first and last week of the period (Table 4). This did not happen in 1989, when there was a lowering of 1.7°C

Table 2

Mean, maximum, and minimum temperatures for February and the starting day of the MPP

Year	Mean temp. (°C)	Maximum temp. (°C)	Minimum temp. (°C)	Day starting MPP	
				(from 1 January)	Julian day
1987	11.91	16.55	7.26	72	March 13
1988	11.89	17.20	6.59	65	March 5
1989	12.93	18.46	7.40	63	March 4
1990	14.25	20.84	7.66	68	March 9
1991	10.17	15.18	5.13	91	April 1
1992	11.89	17.62	6.16	77	March 17
1993	12.59	18.72	6.46	67	March 8
1994	11.74	17.75	5.74	69	March 10
				Average 72	March 12

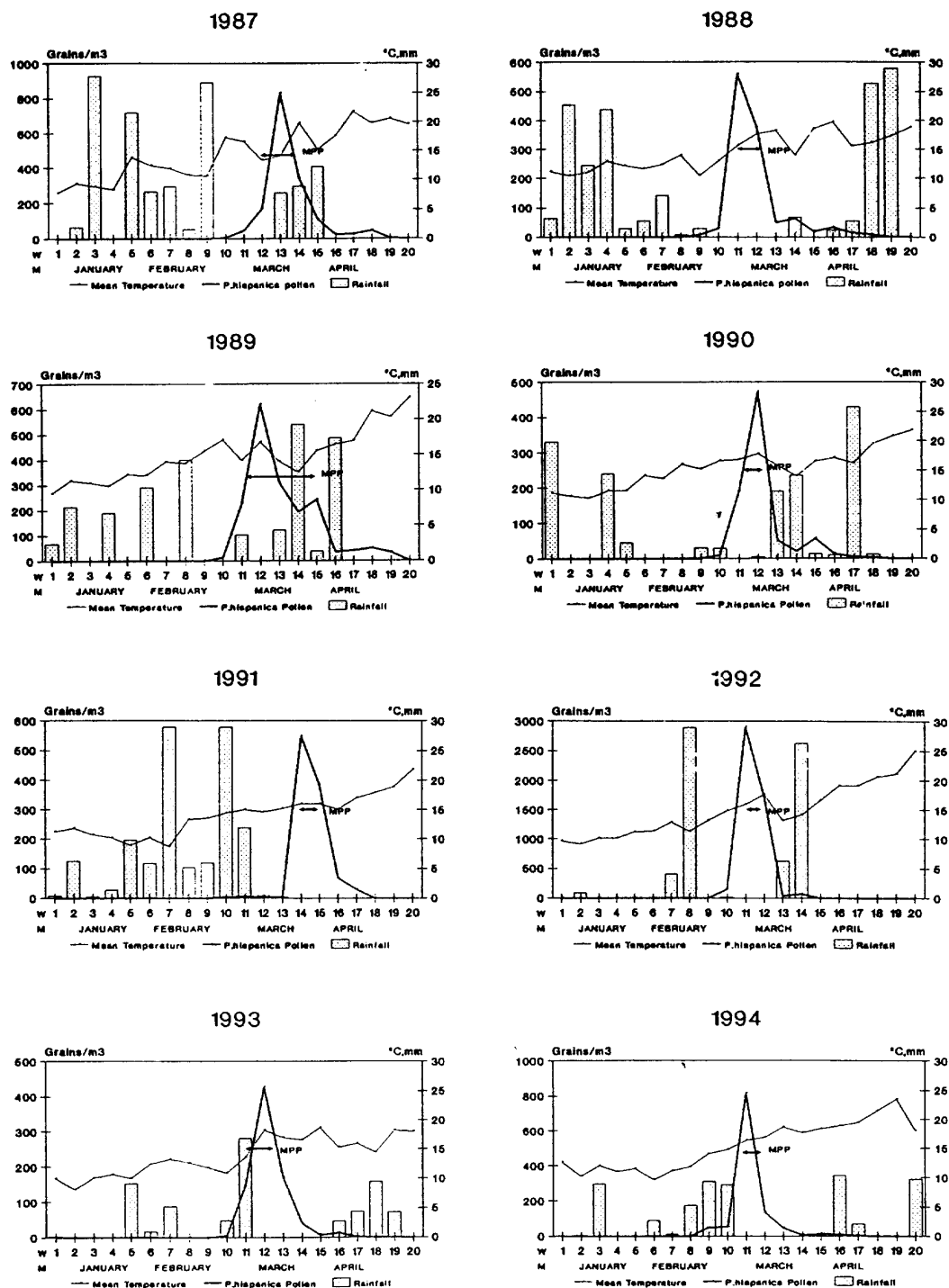


Fig. 2. Seasonal variation of weekly concentrations of *Platanus hispanica* pollen, of mean weekly temperature (°C) and weekly rainfall (mm). MPPs are indicated by double arrow. Years 1987–1994.

Table 3

Aeropalynological data for the week of maximum weekly pollen emission (WMPE): weekly concentration, percentage of this concentration in the annual pollen of *Platanus hispanica*, mean temperature, rainfall, and increase in mean temperature compared with the preceding week

	Week	Weekly concentration (Grains/m ³)	% Representation of <i>Platanus pollen</i>	Mean temp. (C°)	Rainfall (mm)	Increase in temp. ^a
1987	13	833.30	52.00	14.13	15.40	0.79
1988	11	551.53	47.20	15.58	0	2.63
1989	12	619.53	39.30	16.72	0	2.72
1990	12	473.07	57.66	17.80	0.60	0.56
1991	14	548.23	52.57	16.03	0	0.86
1992	11	1216.36	57.38	15.91	0	1.74
1993	12	427.30	52.67	18.24	0	4.60
1994	11	816.95	72.78	16.35	0	1.61

^a Increase in the mean temperature compared with the previous week.

between the first and last week, given that the mean temperature fell to 12.5°C (Table 4, Fig. 2).

The duration of the MPP differed from year to year: 2 weeks (1988, 1990, 1991, 1992, 1994), 3 weeks (1987 and 1993) and 5 weeks (1989) (Table 4). In the first case the duration was related with mean temperatures higher than 16°C and with the absence of rainfall; in the second case, although the mean temperature reached 16°C, there was rainfall (33.1 mm in 1987 and 33.6 mm in 1993), and the period (MPP) lengthened; in the third case, a temperature of 16°C was not reached (the mean temperature was 14.31°C, the lowest of the 8 years) and the rainfall was 54.20 mm (the highest of the whole period), jointly resulting in a lengthening of the period (Table 4).

4. Discussion

Throughout the study period, the sum of weekly pollen concentrations of *Platanus hispanica* pollen was seen to follow a biennial rhythm (Fig. 1). This phenomenon has been reported for other arboreal plants such as *Quercus* and *Betula* (Jager et al., 1991), and could be the result of a pattern of pollen production and emission regulated by endogenous factors of the plant. These interannual fluctuations also depend on meteorological factors prior to the pollen season; thus Roure and Belmonte (1988) and Belmonte et al. (1990) considered that the pollen produced by arboreal plants in general, and *Platanus hispanica* in particular, depend on the amount of rainfall in the months preceding the pollen season. Candau et al. (1994) showed that the seasonal amount of *Fraxinus* pollen is related positively with the amount of preceding rainfall. Our study of *Platanus hispanica* partially supports this, as the positive relation between production of pollen and preceding rainfall was found only in periods of drought (from 1992 on) (Fig. 1).

At the same time, the 11.05% mean representation of *Platanus hispanica* pollen in the total pollen collected by

the end of the year (Table 1) makes it the fourth most abundant pollen type of those identified in the city, after *Olea europaea*, *Quercus* and *Poaceae* (González Romano et al., 1992). This percentage is very interesting, since it is for a pollen type that appears in the air for only a few weeks, and is related directly with the level of the presence of this plant in the ornamental flora of Seville—more than 10 000 individuals. The fact should be taken into account when planning the creation of green areas of cities. As a reference point, this mean percentage of representation of *Platanus hispanica* in the total pollen collected is similar to that found in other large urban areas: Madrid (Sáenz Lain and Gutiérrez Bustillo, 1983), Barcelona (Roses-Codinachs et al., 1992), Turin (Caramiello and Siniscalco, 1990) and Buenos Aires (Majas et al., 1992).

Another interesting result of the aeropalynology of *Platanus hispanica* is the negative correlation between the mean temperatures for February and the starting day of the MPP ($r = 0.73$, $r^2 = 0.53$, $P = 0.0398$) (Table 2). Such correlation has been found previously in *Gramineae* and *Olea europaea* (Frenguelli et al., 1989) and *Olea europaea* (González Minero and Candau, 1996). In our case, the equation relating the two parameters ($D = 140.13 - 5.63 T_{\text{mean}}$) can be used as a model to forecast the start of the MPP of *Platanus hispanica*, with increasing exactness as the number of years of observation increases.

The seasonal variation in *Platanus hispanica* can be classed as 'pollen invasion' in March (or in certain years at the beginning of April). This claim is based on the abrupt presence of large weekly concentrations of pollen (exceeded only by the concentrations of *Olea europaea*—Candau and González Minero, 1992) and on an MPP of 2 or 3 weeks (except in 1989). The MPP of *Platanus hispanica* is the shortest of those found for the pollen types identified in the air of Seville, and is comparable only to those of other trees and shrubs: 4 weeks in *Olea europaea*, *Pistacia* and *Moraceae* (González Romano et al., 1992). The presence of *Platanus hispanica* pollen outside its pollen season is caused by

Table 4

Data of the main pollination period (MPP): duration, mean temperature, rainfall and increase in mean temperature during the main pollination period

Year	Weeks	Length (W)	Mean Temp. (°C)	Rainfall (mm)	Increase in temp. ^a (°C)
198 7	12–14	3	15.76	33.1	5.98
198 8	11–12	2	16.58	0	1.99
198 9	11–15	5	14.34	54.20	–1.70
199 0	11–12	2	17.80	0.60	0.56
199 1	14–15	2	16.01	3	0.86
199 2	11–12	2	16.78	0	1.74
199 3	11–13	3	16.27	33.6	3.29
199 4	11–12	2	16.58	0	0.55

^a Mean temperature of the last week minus mean temperature of the first

reflotation of the pollen deposited on either the plant itself or obstacles close to the plant. This is moved by the wind on disintegration of the globular capitula (July) or by the fall of the leaves (autumn); the concentrations that this pollen type reach outside its pollen season are minimal.

Finally, it is interesting to note the existence of a clear relationship between the seasonal variation of *Platanus hispanica*, the mean temperatures, and the rainfall:

- The pollen season of *Platanus hispanica* is linked to a rise in mean weekly temperature (except in 1989, when there was a decrease in temperature) (Table 4, Fig. 2). This feature has been reported previously in Granada (Fernández et al., 1990) and Orense (Iglesias et al., 1988).
- The duration of the MPP is linked positively to mean temperature and absence of rainfall. Once the period begins, high temperatures and absence of rainfall shorten the period to 2 weeks, (while it may lengthen to 3 weeks with the appearance of rain) particularly when temperatures are lower than normal, as in 1989 (5 weeks) (Table 4, Fig. 2). A similar result has been reported for *Olea europaea* (González Minero and Candau, 1997).
- In all the years studied, during the WMPE (when a high percentage of seasonal pollen is collected), the mean temperatures were higher than 15°C, the rainfall scarce or absent (except in 1987), and there was an increase in mean temperature compared with the preceding week (Table 3)

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